Using energy at maximum efficiency
Solutions for district heating and cooling
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Copenhagen, Denmark
30 years at the leading edge

ABB has been providing innovative, energy-efficient and cost-effective solutions for district heating and cooling networks for more than 30 years.

We have one of the largest installed bases in the industry, market and technology leadership in power and automation technologies, and unrivaled application know-how and process expertise.

Our offering ranges from turnkey solutions for entire district energy networks to integrated products and systems for control and automation, pumping stations and thermal substations. And, it includes start-to-finish project management and an extensive global network of expertise and life cycle services.
District heating and cooling (DHC) is arguably the most efficient, fuel-flexible and environmentally friendly method to produce and distribute energy on the market. It is sustainable, affordable and community-based. Here are seven strong reasons why:

**DHC is energy efficient** - A combined heat and power plant (CHP) that produces electricity and district heating or cooling has an efficiency rate of between 85 and 93 percent, more than double that of the latest fossil fuel plants that generate electricity only.

**DHC is fuel-flexible** – The water that runs through DHC networks can be heated or cooled using any type of energy source – coal, gas, oil, wind, hydropower, solar, geothermal, biomass or municipal solid waste.

**DHC is environmentally friendly** – It has the lowest carbon footprint of any heating technology on the market and is one of the most efficient ways to reduce greenhouse gas emissions.

**DHC enables nations to cut their fossil fuel imports and become self-sufficient producers of energy** using the most cost-effective energy source at their disposal.

**DHC is affordable to consumers** and is significantly less expensive than individual household heating in populated areas.

**DHC is community-based** and provides local people with jobs and local companies with business opportunities.

**DHC is an energy-storage system and integral to the flexible smart grid of the future** – it enables heat to be produced when prices or demand are low, and it can be stored in large-capacity storage tanks until needed.

Helping Denmark become a leader in DHC

Denmark has the second largest market penetration of district energy in the world. More than 60 percent of Danish homes are connected to district heating networks, and 40 percent of that heat is produced by networks supplied by ABB.

Over the past three decades ABB solutions have helped Denmark reduce its energy consumption and carbon dioxide emissions by 30 percent and 60 percent respectively. As a result, Denmark has the lowest energy consumption per GDP unit in Europe, and the most advanced district energy industry in the world.

ABB is proud to have contributed to this development. Fittingly, our center of competence for district heating and cooling is located in the Danish capital, Copenhagen, which has one of the world’s most highly developed district heating networks – one that serves 500,000 people and is monitored, controlled and managed by a state-of-the-art ABB control system and ABB’s market-leading DHC control system library.
“ABB delivered a turnkey solution that has reduced the number of interfaces and ensured that all components and systems were installed and streamlined to keep maintenance and services at a minimum. The end result is secure and stable heat for the consumer all year round.”

Mr. Chen Yuwei
Vice General Manager
Harbin Huaneng Heat Supply Company, China

“Choosing ABB back in 1985 has proved to be a very wise choice. We are completely satisfied with the capabilities of ABB’s control systems. With the ABB SCADA monitoring and control system, we can optimize the district heating operation, which ultimately benefits our customers. Today, we look at ABB as an integrated part of our business.”

Egon Erlandsen
Technical Manager
Frederiksberg Forsyning, Denmark
Reducing risk and life cycle costs with a single supplier
Turnkey solutions for district heating and cooling networks

Drawing on more than three decades of process expertise and a vast number of successfully completed projects, ABB provides turnkey solutions for all types of requirement, be it a new large-scale network or the modernization of an existing network, pumping station or thermal substation.

Our scope of supply extends from project consultation and network design to project execution and life cycle management, and includes all network equipment, from boilers, chillers and heat exchangers to motors, drives, control systems and instrumentation.

This turnkey capability minimizes the financial and operational risk of our customers. It reduces the number of interfaces and eliminates the difficulties and delays of multi-vendor integration. Most importantly, it ensures the correct dimensioning of the process equipment and its integration into a tightly optimized system operating at the highest levels of efficiency and reliability.

ABB supports you all the way

Project management and supervision
ABB provides complete project management and supervision services, from design and procurement to erection, site testing and commissioning. Our ability to deliver fully engineered systems that incorporate world-class power and automation technologies ensures optimized solutions that create value for customers at each stage of the project.

Consulting
ABB offers a unique mix of practical and theoretical expertise in district energy projects. We merge project consulting with project execution in a coordinated and integrated approach to district energy. By working closely with our partners at all times, we are able to consistently produce the most optimal solution for each customer’s needs.

Financial advisory
As one of the world’s leading engineering companies, ABB has access to an extensive global network of financial institutions and agencies. Our scope ranges from strategic planning to requirement analyses, feasibility studies and business plans. ABB’s financial advisory services combine district energy expertise with long experience in the financing of infrastructure projects all over the world.

Concept, design and engineering
ABB solutions are based on the latest state-of-the-art designs and technology. They provide the highest product quality and ensure that the network delivers safe, reliable and affordable heating or cooling at the highest efficiency and lowest cost.

Supply of systems and products
ABB supplies the entire scope of supply in its turnkey solutions for district energy projects. Most of the electrical, control and instrumentations products and systems are manufactured by ABB to industry-leading standards.

Installation and commissioning
ABB installs and commissions its district energy solutions to flawless standards of execution, quality and safety, ensuring that the final product performs at the highest levels of reliability, efficiency and availability.
Training
ABB provides training for engineers, operators and maintenance personnel in the products, systems and technologies of the district energy process, either on-site at your facility or at selected ABB regional training centers worldwide.

Service and upgrades
ABB offers a complete service portfolio including upgrades and life cycle management solutions to ensure that your investment is secure and future-proof (see pages 10-11).

A complete product and system portfolio
ABB has one of the largest product portfolios on the market for the district energy industry. This comprehensive scope of supply means that we know the products, the systems and the technologies that make a district energy network tick and - most importantly - that we know how to integrate them into highly efficient and optimized solutions.

Our product portfolio for district energy networks includes:
- Highest efficiency variable speed drives and motors
- Programmable logic controllers (PLCs)
- Instrumentation
- Cables
- Communication systems
- Switchboards
- Transformers
- Switchgear
- Protection (high voltage and medium voltage)
- Thermal substations:
  - Fully designed, equipped, tested and ready-to-install heat exchanger units
  - Market-leading, energy-efficient pumping stations in all sizes that are fully tested and ready to install

Our system portfolio for district energy networks includes:
- Supervisory control and data acquisition (SCADA) system
- Intelligent Pump Control (IPC) for drives
- District energy library
- Optimal communication solutions
- Interface solutions with GIS, SAP (and other enterprise resource planning systems), computerized maintenance systems (CMMS) and temperature optimization programs
- Thermal substations:
  - Heat exchanger units: Program for the PLC to run the unit in optimal and remote mode
  - Pumping station: Program for the PLC to run the unit in optimal and remote mode
  - Boiler station: Program for the PLC to run the unit in optimal and remote mode
  - For heat-only boilers (HoBs) and CHPs, ABB has developed programs for process integration with the SCADA system

ABB turnkey solutions encompass all the mechanical equipment – heat exchangers, pumps, pipes, boilers, chillers, air coolers, seawater cooling, storage, valves, metering, etc - which is manufactured by selected partners and integrated by ABB into complete district energy solutions.
Boosting the efficiency of the district energy network
Optimized solutions for networks, pumping stations and thermal substations

It’s one thing to supply a district energy solution, it’s another to make it work optimally and efficiently.

ABB provides optimized solutions for new and existing networks, pumping stations and thermal substations. As the market and technology leader in electrical, control and instrumentation products and systems, we know how to correctly dimension and integrate each and every component into an optimized solution that produces maximum heat or cooling with minimum energy consumption.

Our scope of supply encompasses all the mechanical equipment and includes communication systems between and across networks, asset optimization systems and the industry’s leading SCADA system and district energy control library.

ABB’s SCADA system – the nervous system of the DHC network
A district energy network is only as good as the SCADA system that monitors and controls it.

ABB’s SCADA system enables district energy networks to operate at the highest level of efficiency and productivity. It provides robust and reliable process control, and is designed to promote operator effectiveness, ease of use and seamless integration with smart devices and other ABB and third-party control, management, maintenance and enterprise systems.

Equipped with our industry-leading library for district energy networks, ABB’s SCADA system optimizes temperature and differential pressure, detects leaks and faults, monitors the performance of each asset, and provides operators with advice whenever a component is not performing at maximum efficiency.

ABB’s SCADA system is a highly scalable and flexible platform that enables you to extend and evolve the system as your process and business needs change over time. Its ability to integrate information from across the network and make data and trends easily available helps maximize efficiency and minimize operating costs. If needed, the whole system, or a part of it, can be operated redundantly to secure constant availability.

And, by protecting the SCADA system with our life cycle management services, the efficient and cost-effective operation of the entire system assets over time is ensured (see pages 10-11).

Energy efficiency goals that can be achieved with the click of a mouse:
- Increase the difference between the supply and return temperature ($\Delta t$), and keep the supply temperature low by actively using the information supplied by the system
- Increase the cooling or heating ability of the network by targeting poorly performing equipment, made visible by the SCADA system
- Optimize the differential pressure to keep electricity costs low
- Detect cold water plugs before they damage the assets in the network
- Detect faults before they cause downtime and unwanted maintenance costs

Energy-efficient pumping stations
ABB supplies complete solutions for both new and existing pumping stations. Our scope of supply incorporates design, pumps and mechanical equipment as well as the complete range of our power and automation products and systems.

ABB solutions for pumping stations are geared to energy efficiency. Our variable speed drives can cut the energy consumption of pumps by as much as 60 percent and significantly reduce the mechanical and electrical stress on pump components. By equipping each pump with an ABB motor additional energy savings of up to 9 percent can be achieved.

Energy efficiency for multiple pump installations can be further enhanced with ABB value-added products like remote monitoring and our Intelligent Pump Control (IPC) software. IPC can contribute additional energy savings of up to 20 percent on a typical installation. It features 11 pump control functions like flow calculation and sleep and boost, and it eliminates the need for external control devices and reduces the need for maintenance.
Using energy at maximum efficiency | Boosting the efficiency of the district energy network

Efficient and cost-effective thermal substations
ABB supplies complete, pre-assembled and factory-tested thermal substations for large and small installations. We perform the detailed design, select the most efficient products, and correctly dimension the heat exchanger, pumps and pipes. Local control is performed by an ABB PLC to ensure that only the correct amount of water is pumped through the system at the optimal temperature and pressure.

Process parameters are ensured by ABB’s portfolio of products in instrumentation and process analytics. These include flow meters; sensors and transmitters for measuring differential pressure, gauge and absolute pressure; sensors and transmitters for the accurate measurement of temperature; analytical instruments for pH measurement; and indicators, videographic recorders and controllers for precise local measurement.

Integrating the network with the smart grid
District energy is a key component of the smart grid. Its ability to store energy (heated or chilled water) in tanks ready for use when demand exceeds base load, and to harness surplus heat from an endless variety of sources and reuse it for heating or cooling purposes, makes it one of the most flexible energy sources available.

ABB’s SCADA system enables the district energy network not only to collect, store and release the heat at the most optimal and efficient times when electricity tariffs are low, but to manage distribution over the entire network and integrate it with other power and energy management systems.
ABB has spent more than 125 years developing service and maintenance solutions that are geared specifically to the power, water and district energy industries. We offer a full portfolio of life cycle management services, from repairs and spare parts to Full Service® contracts and complete plant upgrades and equipment retrofits.

ABB services are available for each phase of the plant life cycle, from first concept to decommissioning:
- Concept
- Front-end engineering
- Detail engineering
- Equipment selection and procurement
- Construction
- Commissioning
- Startup
- Operation
- Decommissioning

Project management
ABB’s certified project managers take care of all relevant issues during a district energy project – a competent partner for the entire ABB contribution.

Asset management
ABB provides life cycle assessments of critical plant equipment, including component reliability calculation analysis. Our assessments equip district energy and power generators with the information required to make cost-effective, long-term decisions on overall system operation and maintenance. ABB service contracts guarantee that our experts are only a phone call away.

Environmental services
ABB provides benchmark recycling solutions for defective parts and systems. In accordance with all applicable regulations and requirements, ABB takes care of the proper disposal or recycling of installed or returned parts.

A complete portfolio of services
Training
A skilled and efficient workforce is a plant’s most valuable asset. We can increase workforce skill levels and knowledge so that a more productive response to system and process challenges is achieved. Our training programs for engineers, programmers, maintenance and operations personnel provide comprehensive and up-to-date technical expertise in products, processes and technology advances. Training is available on-site, at ABB training facilities or locally at your plant.

Upgrades and retrofits
Our upgrade and retrofit programs focus on integrating all system and control components to provide operational improvements. ABB’s Automation Sentinel Program protects past, present and future control system investments. It keeps control software up to date and maintains a flexible path forward to new system software technology.

Evolution
The ABB life cycle management model provides the framework for evolutionary services that maximize availability and performance throughout the life cycle of ABB equipment. The model enables ABB to provide optimal support to end users and a smooth transition to new software and equipment when a product reaches the end of its operating life. Throughout the product life cycle, ABB continues to provide solutions that expand the functionality and extend the life cycle of the equipment, while maintaining the customer’s core investment.

Diagnosis and consulting
ABB experts have a profound knowledge of global best practices in a wide range of business and engineering operations. We develop and implement service solutions based on industry-specific technologies and competencies to help customers improve overall equipment effectiveness and return on investment.

Support and remote services
Advanced remote technology delivers higher service value and performance. ABB’s portfolio of remote services provides assistance for a wide range of support needs, from telephone and Web support to direct and secure system interaction. ABB remote services offer real-time access to technical specialists globally, service experts 24 hours a day, and direct connections to plants from ABB facilities for system and process diagnostics and checks.

Spare parts and repair services
ABB’s global logistics network provides fast delivery of spare parts and repair services throughout the world, 24 hours a day, to ensure components are delivered efficiently and promptly to your site.

Troubleshooting
ABB engineers are trained and certified to provide expert knowledge for root cause analysis and troubleshooting to bring the plant quickly back to normal operation again.

Maintenance
Our local service teams are backed by global resources, with more than 10,000 professionals ready to provide a fast and efficient response to service needs. Our service professionals are trained and certified to help avoid downtime and get the plant online and in production as quickly as possible. We know that the key to providing world-class service is not only to respond quickly, but provide the best solutions.

Commissioning
We take care of all phases of commissioning, from I/O-check and plant startup to system tuning and acceptance testing.

Installation
We prepare the schedule for delivery and installation in close cooperation with our project partners, and we plan and procure site facilities and provide complete installation.

Engineering
ABB engineers are skilled in control and process technologies and use well-proven tools for consistent and project-wide data storage that can be accessed on site or by remote.
Over the past 30 years ABB has provided benchmark solutions for district energy networks all over the world.

Our reference installations range from large metropolitan networks like Copenhagen and Singapore to small and medium-size networks for local municipalities. They include pumping stations, thermal substations, SCADA systems, refurbishments and new installations.

Each and every ABB solution enables the network to produce and distribute energy at the peak of efficiency, reliability and cost-effectiveness.

20 percent more heat from 50 percent less energy
Ulaanbaatar, Mongolia

Ulaanbaatar is the capital of Mongolia and the country’s largest city. Given Mongolia’s harsh climate, where temperatures can fall as low as minus 50 degrees Celsius, heat is a basic requirement for human life.

Deterioration of the piping and equipment was limiting the capacity of Ulaanbaatar’s heating network to meet this basic need for its one million residents, and was preventing the connection of new industrial and commercial consumers to the network.

ABB was selected in 1998 by the Asian Development Bank to refurbish part of the network and improve network capacity, reliability and efficiency. This required upgrading three CHP plants and equipping thermal substations with ready-to-install heat exchanger units, pumps, motors and drives, and instrumentation, as well as providing a SCADA system to deliver control and automation of the network and increase efficiency.

The results of the ABB solution have been very impressive. CHP energy consumption has been reduced by as much as 50 percent, while providing 20 percent more heat than before the upgrade.

Phase 2 of the project focused on improving the network pumping stations. It was completed in 2009, with a payback period for the customer of less than two years. The ABB solution comprised booster pumps and variable speed drives for five pumping stations, as well as transformers, switchgear, PLCs, instrumentation and valves. ABB was also responsible for engineering and project management.

ABB is currently delivering pumping stations, automation systems and district heating projects for several customers in Mongolia.
Efficient heat and cleaner air for a Chinese city
Harbin, China

The ABB solution brings clean, efficient and optimal heat to one million residents in the Daoli district of Harbin in northeast China. Harbin has one of the coldest, harshest climates in China, with temperatures constantly below zero for six months of the year.

The district heating system ensures residents enjoy indoor temperatures of at least 18 degrees Celsius, and a cleaner healthier outdoor environment made possible by the removal of more than 2,000 coal-burning boilers that consumed 300,000 tons of coal a year.

The replacement of these boilers with a district heating network equipped with energy-efficient ABB technology has significantly reduced annual emissions of greenhouse gases, amounting to 550,000 tons of CO$_2$, 2,200 tons of sulfur dioxide (SO$_2$), 11,000 tons of dust and 75,000 tons of soot.

ABB's scope of supply for this huge project was comprehensive. It includes 110 km of pre-insulated pipes, 186 thermal substations, as well as pumps, valves, instrumentation, variable speed drives, and an advanced SCADA network control system. ABB was also responsible for project management and engineering.

Controlling Copenhagen's district energy network
Copenhagen, Denmark

The Metropolitan Copenhagen Heating Transmission Company (CTR) supplies heat to 275,000 households in five municipalities in the Greater Copenhagen area. The system delivers more than 18,000 terajoules of energy a year via 54 kilometers of double pipes, 26 thermal substations and three booster pump stations.

ABB provided the network’s first SCADA system in 1985 and has continually upgraded and maintained the system to ensure that it meets evolving requirements such as a high degree of automation; fast, redundant and trouble-free communication; and operation from several easy-to-use network control stations that provide access to all vital process information.

The benefits for CTR are many:
- The control system’s high level of automation enables CTR staff to devote most of their time to production forecasting and planning
- Only 25 staff including eight control room operators are required to operate the network
- It requires only two mouse-clicks for any operator at any main station to retrieve any process picture at any time
- A unique detection system ensures that cold-water plugs are detected and regulated before they affect the rest of the network and the end consumer
- Net energy savings are estimated at 290,000 tons of oil and some 1 million tons of displaced CO$_2$ emissions a year as a result of increased renewable heat supply and automated and optimized production
Drives solution increases production by 5 percent

Västerås, Sweden

Mälarenergi operates Sweden’s largest combined heat and power plant. It provides some 13,000 customers in the city of Västerås (population 134,000) and surrounding area with electricity and heat.

ABB conducted an energy audit of the plant and proposed installing variable speed drive systems on the plant’s pump and fan applications to save energy and improve the network’s process control.

ABB replaced the existing resistor-based motor control systems with eight medium-voltage drive systems (comprising drives, motors and transformers) that control the plant’s four district heating pumps, a boiler feed pump, accumulator pump, and the fan and pump for a bio-fueled boiler.

The ABB solution has eliminated the unnecessary energy losses caused by the old flow control method. This has reduced the amount of heat required by the district energy network and increased the volume of saleable electricity by some 35 gigawatt-hours a year, equivalent to about 5 percent of annual plant production.

According to Mälarenergi, the solution has also improved process control and the stability of the district heating network - all in a payback time of just 12 months.

Using waste industrial energy to heat 55,000 homes

TVIS, Denmark

TVIS is a heat transmission company for five municipalities in western Denmark. The company takes excess heat from local industrial facilities and a power plant and uses it to heat 55,000 homes, as well as shops, offices and factories in all five municipalities. The energy and emissions saved is equivalent to 130 million liters of diesel oil a year and 225,000 tons of carbon dioxide.

The heat is transferred to consumers via 30,000 cubic meters of water in a 75-kilometer main network of double pipes. Due to the excellent insulation and the efficient control of pumps, temperature and flow, the heat loss is only 3 percent.

The network’s five booster stations, 28 heat exchanger stations and 19 valve and boiler stations are controlled by an ABB SCADA system from a central control room in the TVIS head office. In addition, each booster station is equipped with an ABB PLC, which is connected to the main SCADA system to enable independent operation in the event of a fault elsewhere in the system.

The SCADA system logs all data and provides automatic control and supervision of the entire network, as well as allowing the operators to manually control the network or parts of it.

The control room design is based on ABB’s Extended Operator Workplace concept, which has a proven track record in producing faster operator response times, correct decision-making and measurable improvements in productivity, safety, information flow and operator job satisfaction.
Cooling Singapore’s Marina Bay business district
Marina Bay, Singapore

The Marina Bay District Cooling System is the world’s largest and most ambitious district cooling network. Located on reclaimed land at the southern tip of the island, Marina Bay is a 360 hectare extension to Singapore’s downtown business district.

The district cooling system currently comprises two district cooling plants. The plants have an installed capacity of 157 MW and provide 1.1 million sq m of commercial space with district cooling, including such landmark buildings as One Raffles Quay and the huge integrated resort complex, Marina Bay Sands.

In time the network will serve the entire Marina Bay area. It will have a capacity of 900 MW and cool around 8 million sq m of space from five cooling plants. The annual displaced CO₂ emissions are estimated by the owners at 23,000 tons at current levels of demand.

ABB provided an integrated electrical, control and instrumentation solution for both cooling plants, including medium voltage switchgear, transformers, LC motor control centers, low voltage and medium voltage drives and instrumentation for pressure, flow, temperature and BTU measurement.

The highly compact footprint of the ABB electrical equipment is particularly important in prime real estate locations like Singapore’s where space is among the most expensive in the world.

One of the network’s outstanding features is the ABB SCADA system, which controls the entire district cooling network. It provides the operators with real-time information on the whole network, enabling them to optimize production in line with demand and energy prices, thus maximizing energy efficiency and minimizing production costs. The SCADA system is highly scalable for future expansion, exceptionally user friendly and highly reliable.

The Marina Bay District Cooling System is owned by Singapore District Cooling Pte Ltd, a joint venture between Singapore Power and Dalkia.